# Space Weather Technical Forecast

Issued on Sunday, 01 October 2023 at 13:20 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of M-flares throughout. Chance of G1 Minor Storm conditions on day 2 (02 Oct).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Moderate with frequent C-class and two M-class flares, peaking at M2.5 at 01/0132 UTC from the northeast. There are eight sunspot regions on the disc. Two new regions have emerged in the east as AR3440 and AR3445 have recently rotated out of view around the western limb. The most notable regions are the two sunspots in the far northeast; the northernmost being numbered AR3451, meanwhile the southernmost, unnumbered region has been the most active, with an M2.5 flare at 01/0132 UTC, this spot has a delta magnetic structure. The unnumbered region has now lost both its gamma and delta magnetic configuration, simplifying with time. The two regions are close enough to have some potential interaction between them. The largest region AR3450 in the southeast, remains relatively unchanged with only minor spot emergence and a Beta-Gamma magnetic configuration. Elsewhere on the disc the remaining spots are all stable and largely inactive at this time, including the two new regions which have appeared recently in the eastern hemisphere. There is some magnetic looping evident in SDO imagery at, or just over the eastern limb in both hemispheres, suggesting further regions may be close to rotating onto the visible disc.

No Earth-directed CMEs have been observed, however a very faint CME was identified from a disappearing solar filament around 30/0350 UTC from the southeast disc. This is passing behind (east) and south of Earth.

**Solar Wind / Geomagnetic Activity:** Solar winds, as observed by ACE at L1, remain at slightly elevated levels, around 420 km/s. Density was below average. The interplanetary magnetic field (IMF), Bt, was weak, below 7nT. The north-south component, Bz, has been mostly negative, varying between +5nT and -5nT. Phi angle was generally positive (away from the Sun). Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3), with one Active period (Kp 4) between 0000-0300 on 01 Oct.

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) was Moderate to High for much of 30 Sep, reaching a peak of 2210pfu at 30/1600 UTC, but has since reduced back to background levels. Associated 24-hour fluence was initially just above the Active (1e8 integrated pfu) threshold, reaching 1.03e8 integrated pfu, before falling below the Active threshold. The observation at 01/0000 UTC was 7.51e7 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Low to Moderate with a chance of further isolated M-class flares.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs. The next notable enhancement is most likely to occur on day 2 (02 Oct) due to the arrival of the fast winds of CH54/+. This feature is currently in the northwest disc, but with a southeastern extended lobe that has a greater potential for a geoeffective connection on day 2 (02 Oct). A further, small coronal hole enhancement (CH55/+) is possible late day 3 (03 Oct) or more likely on day 4 (04

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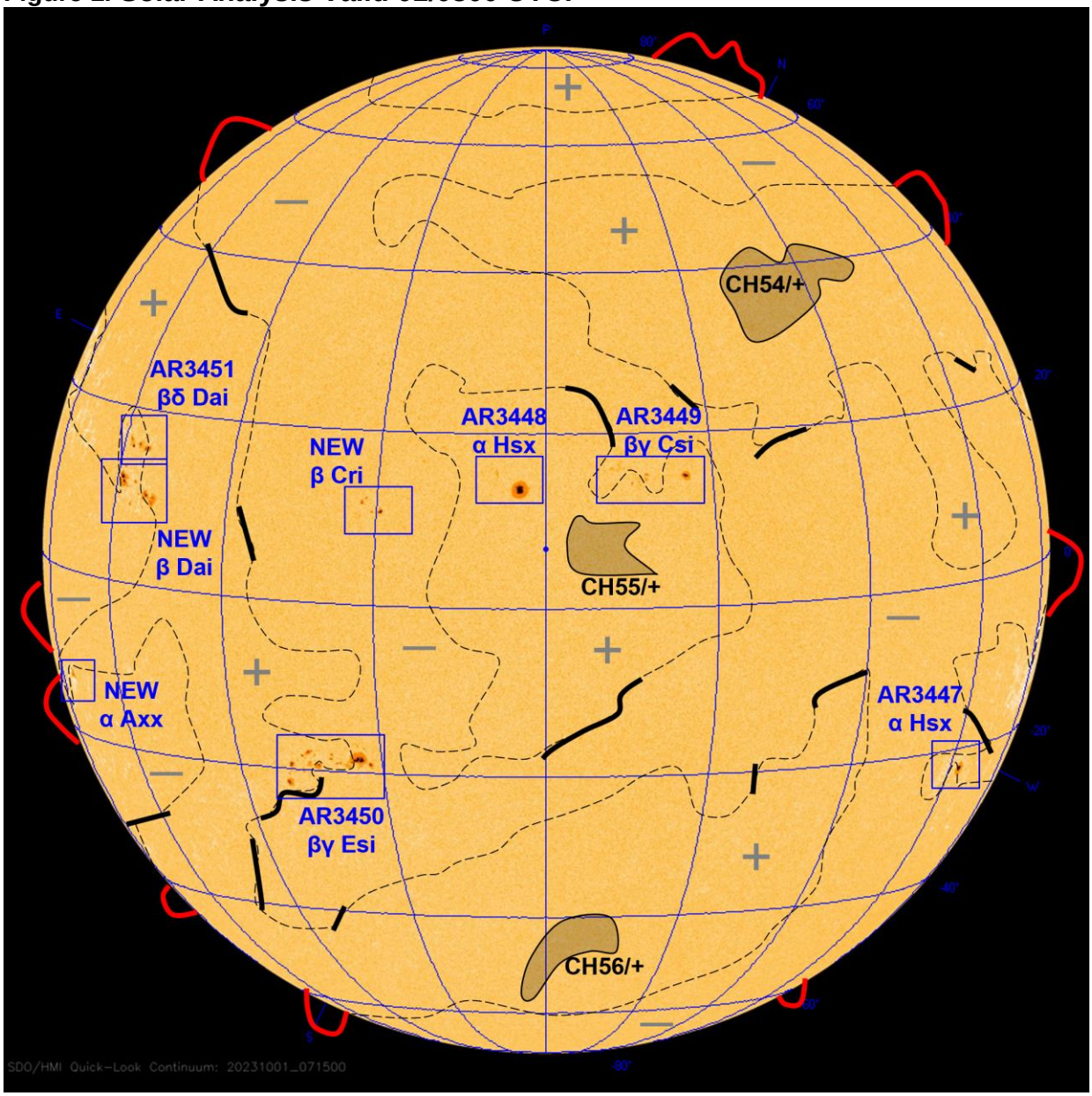
Oct). Geomagnetic activity is expected to be Quiet to Unsettled on day 1 (01 Oct), then Quiet to Active between days 2-4 (02-04 Oct) with a chance of G1 Minor Storms.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with no Solar Radiation storms expected. High energy electron flux (greater than 2MeV) observed by GOES16 is expected to vary between background and moderate levels on day 1 (01 Oct) and some of day 2 (02 Oct). Thereafter a more significant drop-out of electron flux is forecast to occur, related to the onset of any fast winds from CH54/+, however this is fairly low confidence with regards to timings. Fluence is below Active (above 1e8 integrated pfu) levels and is expected to remain below throughout on a generally flat to decreasing trend.

**Figure 1. Solar Analysis Valid 01/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

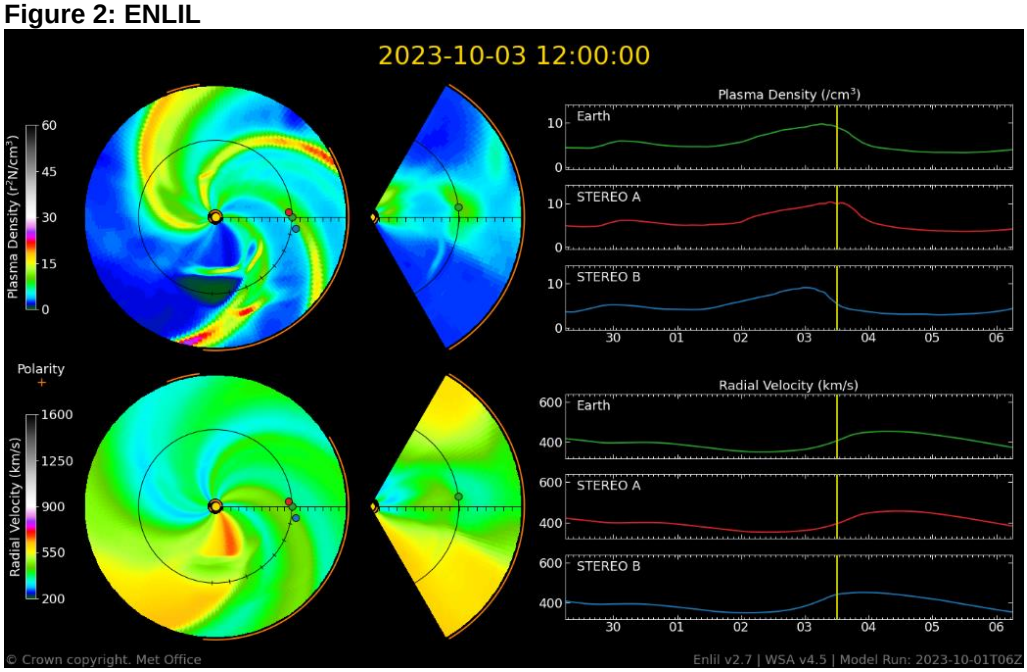
There are no Earth-directed CMEs.

Solar winds are currently around background to slightly elevated levels, with Earth likely south of any notable fast wind influence from CH54/+. This is a broad feature in terms of longitudinal extent, located at mid-high latitudes across the northwestern disc, although a southeastern extended lobe may allow for a transition into its fast wind on day 2 (02 Oct), perhaps bringing speeds up to around 500 km/s. Considering its positive polarity, this is more favoured for a geoeffective connection at this time of year, bringing an increased potential for enhanced geomagnetic activity and is broadly in-line with the current MOSWOC enlil forecast. Late on day 3 (03 Oct) or more likely on day 4 (04 Oct) a connection to the high-speed stream of equatorial CH55/+ is possible. This is a small, non-recurrent feature, therefore any speed increases that might be observed are uncertain. Tentatively, slightly elevated speeds are most likely to occur from this.

Geomagnetic activity is expected to be Quiet to Unsettled on day 1 (01 Oct), then Quiet to Active between days 2-4 (02-04 Oct) with a chance of G1 Minor Storms.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 5 | 30 | 20 | 30 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Figure 2: ENLIL**

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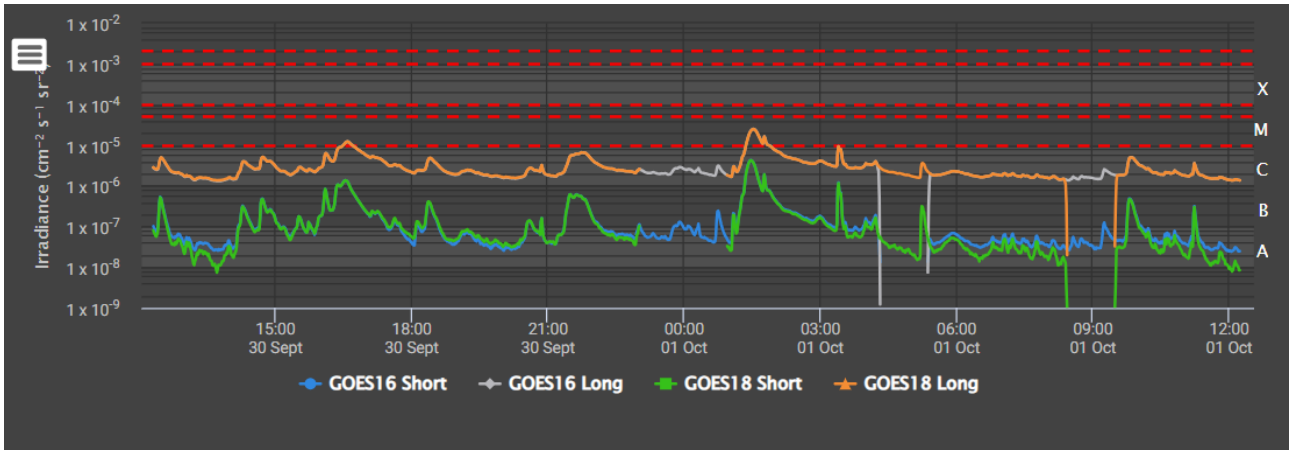
## Radio Blackouts - X-Ray Flares:

Low to Moderate activity is forecast, with a chance for further isolated M-flares, most probably from the three larger regions in the eastern hemisphere.

There are eight sunspot regions on the disc. Two new regions have emerged in the east as AR3440 and AR3445 have recently rotated out of view around the western limb. The most notable regions are the two sunspots in the far northeast; the northernmost being numbered AR3451, meanwhile the southernmost, unnumbered region has been the most active, with an M2.5 flare at 01/0132 UTC, this spot has a delta magnetic structure. The unnumbered region has now lost both is gamma and delta magnetic configuration, simplifying with time. The two regions are close enough to have some potential interaction between them. The largest region AR3450 in the southeast, remains relatively unchanged with only minor spot emergence and a Beta-Gamma magnetic configuration. Elsewhere on the disc the remaining spots are all stable and largely inactive at this time, including the two new regions which have appeared recently in the eastern hemisphere.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 50 | 50 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: Xray flux trace past 24 hours**

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## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, with the current sunspots on the disc not expected to produce proton events.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

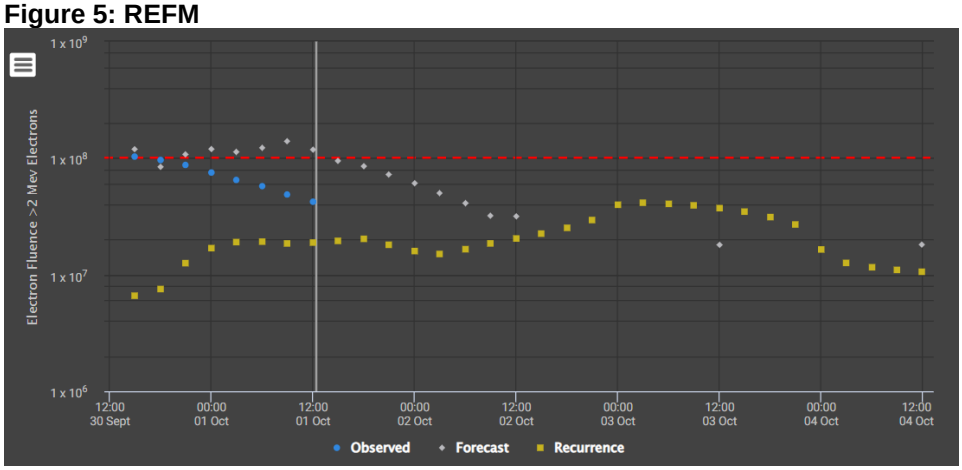
## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 is expected to vary between background and moderate levels on day 1 (01 Oct) and some of day 2 (02 Oct). Thereafter a more significant drop-out of electron flux is forecast to occur, related to the onset of any fast winds from CH54/+, however this is fairly low confidence with regards to timings.

The fluence is below Active levels on a decreasing trend and is expected to remain below. REFM is currently too high for its expected fluence on day 1 (01 Oct), but appears to offer good guidance for the remainder of the forecast period.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | Yes | 10 | 10 | 20 | 20 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 5: REFM**

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